MECHANICS.

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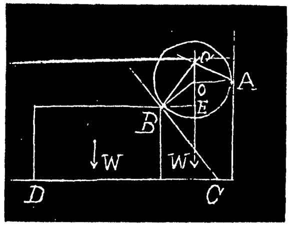
82. Proposed by WALTER H. DRANE, Graduate Student, Harvard University, Cambridge, Mass.

A sphere, diameter $2a$. rests in limiting equilibrium upon the edge of a box and against a vertical wall. If the box be of such dimensions that it will not tip, find the distance of the box from the wall, having given the coefficient of friction between the sphere and wall $\frac{1}{2}$, between the sphere and box $\frac{1}{3}$, and between the box and floor $\frac{2}{3}$. [From Problems in Mechanics proposed to class in Harvard University.]

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Mathematics and Science, Chester High School, Chester, Pa.

Let W=weight of sphere, W'=weight of box, $\mu=\frac{1}{2}$, $\mu'=\frac{1}{3}$, $\mu''=\frac{2}{3}$, $\theta=\angle BCD$, S=normal reaction of wall, R=normal reaction of box, d=distance of box from wall.



$\therefore$ $d=AO+BE=a(1+\sin\theta)$, since BO is perpendicular to BC.

Also $S=\mu' R\cos\theta+R\sin\theta=\mu'' W'$ (resolving horizontally).

$$\therefore S=\tfrac{2}{3}W',\ R=\frac{\mu'' W'}{\mu'\cos\theta+\sin\theta}$$

$$=\frac{2W'}{\cos\theta+3\sin\theta}.$$

Also $\mu S+\mu' R\sin\theta+R\cos\theta=W$ (resolving vertically), or $\frac{1}{2}S+\frac{1}{3}R\sin\theta+R\cos\theta=W$.

The values of S and R in the last equation give

$$\tfrac{1}{3}W'+\frac{2W'\sin\theta}{3\cos\theta+9\sin\theta}+\frac{2W'\cos\theta}{\cos\theta+3\sin\theta}=W.$$

$$\therefore \tan\theta=\frac{7W'-3W}{9W-5W'},\ \sin\theta=\frac{7W'-3W}{\sqrt{90W^2-132WW'+74W'^2}}.$$

$$\therefore d=a\left[\frac{\sqrt{90W^2-132WW'+74W'^2}+7W'-3W}{\sqrt{90W^2-132WW'+74W'^2}}\right].$$

If $W=W'$, $d=\frac{1}{2}a(2+\sqrt{2})$.

83. Proposed by MARY M. BLAINE, B. Sc., Graduate Student, Drury College, Springfield, Mo.

A particle is projected upwards in vacuo with a velocity v. Show that on reaching the ground again there is no deviation to the south, but the deviation to the west is $4\omega\cos\lambda(v^3/3g^2)$. [*Laplace*, iv, page 341.]